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ABSTRACT

The concept of development in education is examined, being defined as "the systematic use of scientific knowledge directed toward the production of useful materials, devices, systems, or methods, including design and development of prototypes and processes." Historical antecedents of present development are briefly discussed. Contrast is made between the manner in which development is conducted when regarded as operating within the boundaries of educational research and practice and when it is regarded as operating within the wider area of scientific knowledge and technological capacity in general. The contrasts are made in terms of dominating paradigms, disciplines, institutions, and time frames. It is argued that the current state-of-the-art of development in education justifies a radical restructuring of the conduct of development, based upon the efforts of other developmental enterprises (defense, space, and industry). Eleven alternate routes for modifying an educational system are described, among them administrative organization, authoritative analysis, legislation, training, and trends. A number of dilemmas (e.g., independence/dependence, competition/ cooperation) are examined, which must be accommodated in order for effective development to take place. Finally, several manpower predispositions favorable to development processes are presented and discussed. (MJB)

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OCCASIONAL PAPER

OCCASIONAL PAPER 14

THE CONDUCT OF DEVELOPMENT IN EDUCATION

by

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FROM

CENTER ON EVALUATION DEVELOPMENT AND RESEARCH

CEDR

PREFACE

In their work educators frequently encounter problems - instances in which there is an intention of some sort that cannot be carried out. These intentions can be listed in at least six categories:

1. *The intention to plan* for the future, to select goals to be accomplished or to modify existing goals.
2. *The intention to operate* education programs, to do the day to day work of the education system.
3. *The intention to know* the generalizable principles and "truths" on which sound educational work is based.
4. *The intention to choose* the best alternative(s) when two or more possibilities exist and the situation precludes using them all
5. *The intention to do*, to carry out educational or related tasks when the tools or procedures are not available for accomplishing the task at the desired level.
6. *The intention to disseminate*, to move information from one locale to another, from one level to another.

When accomplishment of any of these intentions is blocked, a problem exists, the resolution of which demands the use of an appropriate problem solving strategy.

Many people believe that problems related to intentions to know, to choose, or to do are resolved by the same strategy, research. Experience accumulated in recent years questions that belief. Developments in general systems theory lead to the assertion that, if different functions exist, different strategies for achieving them are needed. If a "need to know" problem is different from a "need to do" problem, resolving those problems calls for different strategies or procedures.

The author of this paper, Richard E. Schutz, has, as Director

of SWRL (the Southwest Regional Laboratory for Educational Research and Development), first-hand experience with both "need to know" problems and "need to do" problems. He strongly supports the thesis that the development process, the strategy for resolving need-to-know problems, is different from the research process. His discussion of the development process should help others to those realizations also, a movement quite necessary for more efficient improvement of the tools and procedures needed in educational operations.

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THE CONDUCT OF DEVELOPMENT IN EDUCATION

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This paper was originally presented at the Symposium on Educational Research and Development arranged by David Cohen, Center for Educational Policy Research, Harvard Graduate School of Education for the National Institute of Education, December 11-12, 1972, Washington, D.C.

I. Antecedents and Analogs

Development in education is usually treated as a new phenomenon, with unique characteristics, problems, and potentials. It should not be so viewed, for there are losses in disassociating it from relevant antecedent and concurrent endeavors. Current and projected development phenomena lose nothing and gain a good deal by admitting to phenomena that came before and that coexist. Here and throughout the paper the term "development" is used with the standard referents of the National Science Foundation definition (1965) "the systematic use of scientific knowledge directed toward the production of useful materials, devices, systems or methods, including design and development of prototype and processes." Several alternative definitions of development in education have been offered to justify a wider range of phenomena or to incorporate characteristics regarded as unique to the educational context. These departures from standard usage appear neither necessary semantically nor desirable instrumentally and again reflect the tendency to isolate education from the human mainstream.

Antecedents of Development in Education

The antecedents of educational development can be traced to antiquity, but the history may also be accounted in short order. Up until the last century, the history of educational development is totally accounted for by the history of educational practice. Materials, devices, and so on were being produced on the basis of the scientific information then available. But development was conducted as part of the general educational enterprise.

During the twentieth century, research in education came to have established referents as an enterprise apart from educational practice. Utilizing the methodology of the behavioral sciences, largely psychology, a large quantity of education research was amassed. Whether this literature constitutes knowledge is moot, but the research reports did occasionally spawn development activity. Practitioners also continued to use available knowledge to produce useful materials and devices. Thus during the last century up until the mid 1960's development in education was conducted either within the boundaries of educational research or

within the boundaries of educational practice.

Within the last decade increasing attention has been given to development in education as an endeavor warranting consideration apart from educational research and practice. But the endeavor has been seen as naturally building upon and extending historical antecedents in educational research and practice. At the risk of heresy charges from colleagues in educational research and practice with whom I proudly identify, I am compelled to a radical alternative perspective.

Development in education, now and in the future, can best be conducted by breaking sharply with its historical antecedents. Although the historical seeds of educational development lie in educational research and/or practice, the seeds do not have within themselves the wherewithal to provide the nurturance that will now permit development in education to thrive above ground. Energizing sustenance can, however, be provided by experiences in science and technology in fields other than education, and it is here that we shall look in this paper. By breaking through its historical shell of educational research and practice, and driving its roots into broader scientific and technological knowledge, educational development at this point has its best chances of flowering and propagating in the future.

Analogs for Development in Education

Since the botanical metaphor has serious implications for the conduct of development in education, I shall substantiate it by contrasting the manner in which educational development is conducted if regarded as operating within the boundaries of educational research and practice and the manner in which it is conducted if regarded as operating within boundaries of scientific knowledge and technological capacity generally. The contrast will be made in terms of dominating paradigms, disciplines, institutions, and time frames.

Paradigm Perspective

The contextual paradigm for educational research and practice has been Mark Hopkins on one end of a log and a student on the

other. All manners of characteristics of students and teachers have been identified, compared, and correlated in an attempt to enhance the human characteristics and optimize the human enterprise of education In focusing on the inherently human aspects of Mark Hopkins and the student, the inescapable log on which they sit has been largely ignored. As a result, the developed useful materials, devices, systems, and methods that characterize other facets of modern life are not now present in education

Despite impressive edifices and embellished interiors, the typical school is an impoverished instructional environment Compared with even the typical home the classroom is barren. The call here is not for clutter nor for what educators term realia It is for a perspective that is orientated toward providing developed items with demonstrated functional utility in instruction rather than expecting especially creative teachers and naturally ingenious students to make do with items that have for the most part been developed to fulfill other functions The "teaching machine" quest was in retrospect just as simplistic as a "household machine" quest would have been had development for the home been similarly viewed. But had the conduct of development for the home all been restricted to manipulations of the occupants thereof the household would not be the sophisticated functional environment it is today

The product goals of development in education are in no sense inconsistent or incompatible with the intrinsically human characteristics of education People are not products, people use products Educational products, like other products people use, provide alternatives that human beings may choose to use to extend their capability By scrupulously maintaining the distinction between the people involved in educational practice and the products derivable through educational development, humanistic problems are not completely solved, but they are addressable within a human mainstream that includes education rather than isolates it as an enterprise demanding unique attention.

Discipline Perspective

Educational research and practice have traditionally looked to the behavioral and social sciences for their knowledge base, since

these disciplines are viewed as addressing the human characteristics of education. While development in education can certainly draw upon the knowledge base of these disciplines, it is unnecessary and undesirable to restrict its consideration to these disciplines. Fields including but not limited to aerospace, architecture, business, engineering, and pharmacy have associated knowledge that is currently relevant to development in education and that can be expected to advance the state-of-the-art in the future.

The relevance of the fields just enumerated is by transfer of their structural and management strategies at a macro-level rather than transfer of their personnel or applications at a micro-level. These technically oriented fields have been less self-conscious concerning their methodologies than have the behavioral sciences, and thus have given only modest attention to packing their macro-strategies in a form readily cognizant to persons within the field or transferable to other fields such as education. Thus the typical specialist within these fields is not now in good position to contribute to the conduct of development in education. He has adopted the view of education as a field apart and when confronting education either has no response or emulates his notion of how a teacher should respond. In either case he appears foolish.

It is the methodology not the men of aerospace, architecture, business, engineering, and pharmacy that renders these fields ripe for contributing to development in education at the present time. The prevailing methodology of the behavioral sciences seeks to isolate differences and to evaluate comparatively. The predispositions and techniques that follow from behavioral science methodology tend to be disfunctional in development. A counter methodology seeks to identify commonalities and to evaluate cybernetically. The predispositions and techniques that follow from this alternative methodology tend to be highly functional in development and are shared in common by intellectual endeavors in the fields enumerated above. But the typical behavioral scientist must suppress strong competing orientations in order to acquire the "new" predispositions and techniques. His quest for comparative differences in phenomena blinds him to the syncretic

characteristics of the same phenomena.

Institutional Perspective

Educational research and practice have looked to the higher education sector for supportive sustenance. The higher education sector has controlled the personnel and structure of schools through certification and accreditation complexes. It has also controlled the substance of schooling by providing the rhetoric, paradigms, texts, and research that determine this substance. One need not take a position on the quality with which these controls have been exercised to concede that there are disadvantages in lodging development in education within higher education.

Experience in development in other fields suggests that the industrial sector, rather than the higher education sector, is the best fulcrum for development in education. The reasons for this pertain to fundamental characteristics of the university and of the development enterprise that are not readily compatible. The university is the undisputed home of science. Charles Eliot's turn-of-the-century definition of the university is still accurate: "a voluntary cooperative association of highly individualistic persons for teaching and advancing knowledge" (Wolfle, 1972, p. 94). The institution of higher education is admirably equipped to forward research, but the individual autonomy, conceptual elegance, and fragmented specialization characteristic of higher education are wasted in driving the development engine. This is in no way to suggest that educational development in a university context be proscribed or that research related to development in education should be relegated to the university. It is to suggest that justification for educational development activity in higher education be research-based and that justification for research activity in industry be educational development-based.

American industry has no current development capability in education; there has been no basis of support for this capability. The education market has been relegated to "publishers," a small and weak industry. American industry, in general, has been twice burned in the last decade in new venture areas in education other than publishing. Efforts to penetrate educational practice via teaching machines and via performance contracts did not prove

profitable economically or effective professionally. Remnants of these two abortive movements remain alive today, but the scar tissue left in their wake is also present.

The industrial sector has no unique potential for conducting research in education or for operating schools. It has great unique potential for conducting development in education. This potential includes matters of management capability and socio-technical strength that make it eminently reasonable and feasible to lodge educational development in the future in the industrial sector of the nation.

Temporal Perspective

Educational research and practice have been motivated either by blind faith and infinite patience or by alleged crises and instant "solutions." These patterns have been reflected in educational legislation and in public information pertinent to education, but they are irrelevant to development in education. While it is possible to motivate educational development by blind faith and infinite patience, it is not necessary to do so. The tangible referents for development outcomes and the finite estimates of development completion dates permit greater specificity of motivation than blind faith. Likewise, it is possible to cast development in a solution-to-crisis mold, but it is not necessary to invent a crisis to motivate development. Development can, indeed, make a contribution to the solution of real crises. But it can also contribute outcomes motivated by the anticipation of positive potential rather than by the avoidance of crises created for that purpose.

Apart from motivational rationale, both the "instant-infinite" and the "one-year" time frames in which educational research and practice have been fielded are altogether unrealistic for development in education.

In fields other than education a ten-year time frame is treated as the minimum possible time for fielding a development effort from commitment to completion, and a quarter of a century is not uncommon. This may seem like an inordinately long time, but it can be confirmed by adding up the years (Bright, 1969).

Assume that a set of concepts can be demonstrated in application form, so that a development effort may reasonably be *initiated*. "How long will it take to achieve a prototype for full scale or field trial? One to four years? Assume two years. Then how much longer until commercially saleable products with necessary adjuncts in the form of maintenance, user training aids, promotional support, etc. is ready for sale? One to four years? Assume six years. Using these rough assumptions on the optimistic basis the total time is about 10 years! Now allow for the fact that we may be lucky in shortening some of these phases, but are more likely to have under-estimated at least one of them. Then a 15-year time span is a strong probability" (p. 38). If you doubt the applicability of these parametric figures for education, check them against the current planning frames of educational publishers. You will find that their offerings for the late 1970's and early 1980's are now determined. Notice that the additions above started at the time that the scope of the development could be well-enough specified so that development effort could be started. the prior time for inquiry to achieve this level of specificity was not included and would still further increase the time span were it accounted for.

It has been a popular pastime in both educational research and practice to despair over the time interval between the invention of a concept and its reflection in prevailing practice. But this despair has produced only hand waving or wringing. What is not recognized is that it is not the gap that is unique to education, but the effort that achieves successive waves to change the definition of the gap. General convention (Kuhn, 1962) recognizes these successive waves that change the nature of the gap as scientific and technological "progress." It is this absence of change in the nature of the gap between thought and practice that has uniquely characterized education, not the gap per se.

Coda

If development in education is viewed in terms of one person (looking like hundreds of university professors and their graduate students or like millions of individual teachers working in isolation), and in terms of thousands of dollars for a few years (looking like a research project or like an avocational pursuit), it

can be dismissed as inconsequential. There is no way that the conduct of development in education can immediately match the sophistication of development in other areas where the development endeavor is currently established and valued. However, it is in these areas rather than in educational research or practice that relevant analogs are to be found.

The current state-of-the-art of development in education justifies a view of its conduct in terms of managed personnel (looking like industrial R&D organizations) and in several million dollars for several years (looking like small resource commitments to development in areas other than education). Elaboration and defense of this contention will motivate the remainder of the paper. An elegant analysis of the precedents for the radical restructuring of the field that is being called for here has been presented by Platt (1970).

II. Structures and Systems

A radical restructuring of the conduct of development does not demand or imply either unfettered expansion of activity or didactic appraisal of practices. It does require a paradigm that provides a comprehensive structure for the endeavor. Paradigms growing out of educational research or practice that use categories of academic disciplines, human attributes, demographic divisions, and so on, do not fit the development endeavor and lead to gross distortion and misinterpretation when applied to the development context. Neither are macroparadigms that use categories of research diffusion, dissemination, evaluation, and so on any more useful. Irrespective of their merits or deficiencies for other purposes, these categories beg the issue of structure for the conduct of development. Finally, in eliminating structural contenders, we can discard miniparadigms of *the* development method that use categories of design, engineer, test, iterate, and so on. Like paradigms of *the* scientific method, these miniparadigms prove useful if treated as background boilerplate, but are dangerous if believed as trustworthy templates for action.

What does this leave? Fortunately, the shelves are not bare. The goods have been delivered by structures growing out of the

conduct of development in societal enterprises other than education. The best-documented experience derives from defense and space development. The public information aspects of defense and space have subordinated the interpersonal and management aspects of these enterprises to hardware that can easily be photographed and simply depicted in a form amenable to the popular media. However, after cutting below this press image it becomes clear that all of the people problems that are found worrysome in development in education are also present in space and defense development. They have simply received less emphasis. Missiles are not men but management structures are management structures and people are people in development wherever it is conducted. This undersimplification is offered not to support but to introduce the paradigms to be presented. The paradigms are offered as illustrative alternatives rather than as definitive imperatives. As further experience in development in education is gained a more suitable paradigm will no doubt be produced. But future action need not be a bootstrap effort. Development in education may proceed by standing on the structures of giants who have come before.

DOD-Borrowed Paradigm

Table 1 is adapted from a survey of DOD categories presented by Glennan (1967). Glennan's categorizations are paraphrased and freely adapted to reflect and incorporate distinctive characteristics of education. A brief description of each category is followed by suggested prerequisite criteria for effort initiation that define the boundaries of each category. This paradigm has several things going for it. First it permits concurrent coordinate activity that successively reduces the uncertainty inherent in development. Second, it hedges the risks encountered in contracting for the total procurement at one time, promotes reasonable competition within each category, and guides the anticipatory expectations of all parties involved. Third, it permits a healthy range of contractor specializations with sufficient differentiation and stability and with reasonable redundancy to span the full development time frame. Other advantages and implications could be cited, but I shall resist further embellishment, since the purpose is only to set forth the paradigm.

NASA-Borrowed Paradigm

Table 2 is adapted from an impressive analysis of management style and organization structure presented by Sayles and Chandler

Table 1

CATEGORIES FOR AN R&D MANAGEMENT STRUCTURE IN EDUCATION

I *Research* includes all efforts directed toward increased knowledge of natural phenomena and environment and toward solutions to problems in the physical, behavioral, and social sciences By definition, "research" includes all basic research in addition to applied research directed toward expanding knowledge in various scientific areas. It does not include time-oriented investigations and developments.

Effort initiation criteria:

1. The utility of the *potential* outcomes of the research is high
2. The scientific or technological domain is judged to be ripe for exploration
3. Talented scholars and scientists are available or recruitable

II *Exploratory development* includes all efforts to resolve specific problems short of major development projects. These efforts may vary from fundamental applied research to sophisticated experimental prototypes study, programming, and planning efforts The dominant characteristic of this category of effort is that it is pointed toward specific problem areas, with a view toward developing and evaluating the feasibility and practicability of proposed solutions and determining their parameters.

Effort initiation criteria:

1. The technical feasibility of a promising model is uncertain and warrants further investigation, *or*
2. A requirement for a prototype or component can be specified with sufficient precision to permit further effort to refine the specifications, *or*

Table 1

3. Experimentation is required to investigate the parameters of performance limit of a prototype or component of a subsystem, *or*
4. The effort involves the testing of a model preparatory to the development of a prototype or component of a subsystem and the technology for such effort is available.

III. *Advanced development* includes all efforts that have progressed to the development of systems for experimental or operational tests. Advanced development is characterized by line-item projects, normally involving systems designed for test or experimentation as opposed to those designed and constructed for operational educational use. The major distinction is in terms of readiness for use.

Effort initiation criteria:

1. A promising exploitable technology is available and the priority or magnitude of the effort is too great to warrant consideration as exploratory development, *or* the nature of the effort is such that more extensive management is required to insure continuity or cost control than is reasonable under an exploratory development effort.
2. Primarily development rather than experimental effort is required and the technology need is sufficiently in hand.
3. The system and performance objectives have been defined.
4. The best technical approaches have been selected.
5. A trade-off analysis of alternative system configurations has been made.
6. The cost effectiveness of the proposed item has been determined to be favorable in relationship to the cost effectiveness of extant items.
7. Cost and schedule estimates are credible and acceptable.

IV. *Operating program development* includes efforts directed toward the full development, engineering, and testing of all of the essential systems, support programs, vehicles, materials, and procedures that have been demonstrated ready for installation and operational use.

Table 1

Effort initiation criteria:

1. Primarily system articulation rather than system development effort is required, and the technology needed is sufficiently in hand
2. The operating environment and performance envelopes are defined.
3. The best technical approaches have been selected.
4. A thorough trade-off analysis of alternative program configurations has been made
5. The cost effectiveness of the proposed program has been determined to be favorable in relationship to the cost effectiveness of competing potential programs.
6. Cost and schedule estimates are credible and acceptable.

Installation/operation. The category subsumes operating cost evaluation, production-marketing, installation, and operation. Operation is relevant to R&D only to the extent that it reflects such post-installation activity as the setting of standards over time

Effort initiation criteria:

1. All systems involved in a new operating program are available or a firm availability date can be projected.
2. The cost effectiveness of installing the new program has been determined to be favorable when compared with that of current operating programs.

Table 2

PHASED DECISION POINTS FOR THE CONDUCT OF DEVELOPMENT IN EDUCATION

Phase	*Objectives*	*Agency*	*Contractor*
A. Preliminary Analysis	Analysis of alternate overall approaches and concepts	Primarily an in-house effort	Support role for study contractors (FP or CPFF contract); need not be capable of Phase B, C, or D.
B. Definition	Selection of one of several approaches for further definition and eventual development if this seems advisable; effort may be cut off here	An analysis role	Study contractors develop information (FP or CPFF contract); not a competition for Phase D contract.
C. Design	Definition of detail of the approach selected in Phase B	Integration and validation of Contractor data	Major portions of work are contractor conducted (CPFF or incentive contract); generally 2 or more prime contractors selected, only firms capable of performing through Phase D are eligible since Phase C provides competition for Phase D.
D. Development	Final design, development and testing	Monitoring and review functions	Major portion of work is contractor conducted, restricted to Phase C contractors except in unusual cases, one prime contractor (incentive contract).

(1971) that relies heavily on NASA experience

The information in Table 2 is given only incidental treatment by Sayles and Chandler and is not the basis for my praise of their book. . . offer the paradigm to show an alternative formulation that happens to be compatible with the structure in Table 1 and that presents additional facets of the endeavor, such as the appropriate differentiation of agency-contractor responsibility and type of contract If the paradigm were to serve no function other than to provide a contrast with the erstwhile "procurement practices" of USOE to write RFPs for R&D, based on the pet notions of agency staff at expenditure levels of whatever they could scrounge out of annual appropriations residuals, it would serve a useful purpose But the Table implies more than this In elegant simplicity it quietly structures the resolution of complex socio-technical issues that, in education have generated nothing more than heat in skirmishes surrounding "free competition," "federal control," "autonomy and independence," "public and private," and so on Again, I shall resist further embellishment of these desiderata

Both of the foregoing structures are characterized by (1) *incremental acquisition*, based on a sequence of decision points and a succession of development phases and (2) pronounced *austerity* in the early phases of development (Perry, 1972) It may be professionally impolitic to advocate austerity of any sort in this present season of financial adversity for development in education I have no aspiration to outslash the budget slashers The austerity being advocated is structural, not financial: It is offered as an alternative for the present anarchy that imposes austerity, controls late rather than early in development This anarchy is exemplified in the erstwhile USOE practice of laissez faire development followed by a "county fair" competition among "product" entries vying for NCEC-sponsored "dissemination" prizes with the judges supplied by the higher education and school communities and the fairground operated by ETS under contract to NCEC The "county fair" strategem would be inconsistent with the largest national resources imaginable for development in education The decreasing austerity strategem is operable with the national resources presently available for development in education

"Austere initial development is an important element in any

Table 3

OBJECTIVES-BASED R&D CATEGORIES

Support of Existing Business Research - This research is that conducted in direct support of the given company's existing business to maintain or improve its profitability, and to improve its social acceptance. It is conducted to retain or increase market share by introducing new products, by improving the quality of existing products, by decreasing the cost of manufacture, or by preventing excessive increases in cost of manufacture, by extending the market of existing products into new applications, by enhancing safety, reducing pollution, or in other ways improving product or market acceptance.

Exploratory Research - Exploratory research is that research performed for the purpose of advancing knowledge of phenomena of general company interest and also for finding major new high risk business projects. It is usually long range in nature but may include literature searches, laboratory scouting experiments, preliminary application and engineering studies, and preliminary economic evaluation. A new product, process, or service is in view, but the work, by definition, remains "exploratory research" until a product or process objective is established.

New High Risk Business Project Research - New high risk business project research is that conducted with the intention of developing a product, process, or market in which the sponsoring company has no direct manufacturing or market experience, or both. It includes those projects which involve a diversification or a totally new way of accomplishing an important function. It is high risk in nature. This research may result from the successful accomplishment of exploratory research or may be a new program related to otherwise acquired technology. It can include all the technical categories of work associated with research and development.

Table 4

ALTERNATIVE ROUTES FOR MODIFYING AN EDUCATIONAL SYSTEM

Route	*Examples*	*Prerequisite*	*Vehicle*	*Effect Dependent Upon*
Administrative Organization	Experimental schools Storefront schools Day care centers	Defined workable structure	Institutional organization	Institutional leadership
Authoritative Analysis	Kerr Commission reports Levien report California Master Plan	Analysts and commission	Report and publicity	Public acceptance and executive interpretation
Development	Sesame Street SWRL Kindergarten Program PLATO	Development technology	Developed system	Quality of development
Evaluation	EEO survey National Assessment State Testing Programs	Evaluation technology	Report of findings	Evidence and recommendations
Judicial Ruling	Supreme Court ruling Circuit Court ruling State Court ruling	Statute and claim	Court order	Legislative and executive reaction
Legislation	Federal law State law Local law	Legislative majority	Statutes	Executive enforcement

Table 4

Route	*Examples*	*Prerequisite*	*Vehicle*	*Effect Dependent Upon*
Media	Cable TV Computer systems Audio cassettes	Medium and message	Hardware-software	System quality
Personal Service	Education extension agent Management consultant Psychotherapist	Knowledge-embedded-in-individual and receptive client	Interpersonal relations	Individual expertise
Technique	Micro-teaching. Busing Finance formulas	Reliable defined procedures	Media for transmission	Technique and medium
Training	Teacher education Graduate fellowships AERA presessions	Training system	Instruction	Instructor and materials
Trend	Career education Preschool education Open schooling	Multiple convergent determinants	Disjointed incrementalism	Continuity of determinants

incremental acquisition strategy....During development, the desired product is information, and only information. Hardware is merely a means of acquiring the information needed to proceed to another phase.. Irrelevant information is inevitably expensive and frequently worthless It is unlikely, for instance, that consumption rates and maintenance requirements can be accurately calculated before test articles are in hand and test experience has been accumulated Making such calculations is costly. Acting on them before they can be validated is *very* costly" (Perry, 1972, p. 358).

Industry-borrowed Paradigm

The notions of purposive phasing in R&D are not restricted to public R&D enterprises Table 3 shows classifications and definitions recommended by the Committee on Research Definitions of the Industrial Research Institute (Brown, 1972). The Committee "did not find it helpful to classify R&D by how it is done (fundamental, basic, applied), or by where it is done (central labs, divisional outposts, semi-works, on the bench); or by whether the research is product or process oriented They found it most helpful to classify the research on the basis of why it was done" (p. 56) By substituting educational for business referents, the tabled categories appear readily generalizable to development in education

System Modification Alternatives

The paradigm in Table 4 dimensionalizes alternative routes for modifying an educational system. Several implications may be drawn from the array

First, the array indicates that it is possible to structure the management of educational change independent of references to categories of students, teachers, disciplines, and methods It is quite feasible to use multiple descriptors to characterize any modification effort, but excluding descriptors appropriate to a given effort in deference to descriptors appropriate for the management of another enterprise is indefensible

Second, the array encourages an open and pluralistic approach to educational change It recognizes development as one of several feasible routes. Each route has unique strengths and potentials, and none is without its constraints and weaknesses. It is inappropriate to subsume all the routes under the rubric

Table 5*

ESTIMATED[1] COST FOR EDUCATIONAL INNOVATIONS

Type of Innovation	*Cost*	*Delivery Time*
Major Curriculum Projects (such as BSCS, new-math, etc.)	10-15M	5 - 7 yrs.
New Innovations in Media and Technology (such as Sesame Street, Computer Assisted Instruction)	10-15M	3 - 5 yrs
New Efforts at Assessment - Accountability (National Assessment Program, Belmont Project)	15-20M	8 - 10 yrs.
An Experimental School	5M	5 yrs.
Major Studies in Financial Reform	5M	3 - 5 yrs.
Training One Hundred Senior Researchers	6M	4 - 5 yrs.

[1]Estimates provided from National Center for Educational Research and Development, Office of Education.

*Excerpt from Testimony before House Select Subcommittee on Education by James J. Gallagher, February 18, 1971.

"development," as USOE has done in the past, since differential treatment is in order for each. The array recognizes that there are several ways to skin a cat, and that each way has its distinctive features. Grabbing the sharp end of the knife with both hands creates difficulty because it fails to respect the distinctive features of that route. I apologize for the crude metaphor, but it aptly expresses the clumsy efforts at educational system modification that dot the past.

Third, the alphabetical ordering of the alternatives indicates that they are complementary rather than competitive, coordinate rather than hierarchical. A popular gamesmenship ploy in recent years has been to disparage all routes except the one being promoted as "minor tinkering" in contrast to the great "cost benefit" promised by the route being advocated. As a matter of fact, it is unnecessary to select one route as "best" since it is possible to pursue concurrent routes at no increase in cost to education. Each route has unique but complementary strengths and potentials, and none is without its constraints and limitations.

Fourth, the array provides a basis for parametric estimates of the resources required to pursue efforts along each of the routes. Present experience permits the assignment of time and cost estimates to efforts within several of these categories. Table 5 addresses this point. I do not vouch for the precise accuracy of these estimates since my own estimates differ, give or take a few million and a few years. It is my understanding that more refined study of parametric effort boundaries were prepared in connection with NIE planning, but so far as I know this study has not been made public. My point is that the state-of-the-art does permit such parametric estimates and that development in education in the future need not be planned and fielded in ignorance of such estimates. Parametric estimates may also be applied to the costs of creating the institutional capability required to provide the prerequisites for pursuing each route.

Finally, the array suggests differential regulatory criteria appropriate to guide efforts along the various routes. The establishment of regulatory criteria is a traditional arena for healthy focused cooperation between a governmental agency and allied professional associations. Had NCERD officials and AERA members, for example, conjointly devoted half the attention to

defining and legitimizing th criteria for development outcomes that they directed toward evaluating and legitimizing the evaluation of development efforts in the total absence of such criteria, both the state-of-the-art of development in education and the public would have been better served. In their zeal to "win one for old OE," NCERD consistently vacillated between a "We'll solve all your problems," and "Don't bring any of your problems to us." position with its development contractors. This orientation totally abrograted the regulatory mechanisms that have traditionally proved successful in other areas of federal government A federal agency runs a high risk in meddling directly in contractor affairs It smooths out problems by establishing firm regulatory boundaries within which contractors may operate in the interests of all parties concerned.

III Management And Manpower

Management Considerations

"Management" is a nasty word both in many quarters of academia where its connotations of regimentation are abhorred and in many quarters of government where its connotations of control are feared However, management is inherent to the conduct of development, and its pejorative connotations can be avoided by explicit action toward this end Such action involves addressing and accommodating dilemma that inherently affect all persons involved in a development effort These relate to such matters as

Precision - Ambiguity
Independence - Dependence
Competition - Cooperation
Refinement - Completion
Effecting - Marginalizing

Classically, the terms on the left have been considered to be the preferred choices However, the terms on the right, in reality, come closer to a reasonable resolution. There are no magic rules for handling these management matters, any more than there are for handling other matters of development.

Literature on the above topics is sparse. Derek Price (1970) has pointed out that technology, in general, tends to be

papyrophobic in contrast to the *papyrocentric* concerns of science. These tendencies appear to result from determinants of personal property rather than intellect.

"If you want to make capital out of technological discovery (whether the discovery be individually or institutionally referenced), the last thing you want is that open publication that determines private property for the sciences" (p.8). It is possible, however, by borrowing heavily from Sayles and Chandler (1971) to at least sketch the boundaries of the apparent paradoxes (Page number citations without name references in the text below are to their book.) Resolving the paradoxes is one of the intellectually exciting aspects of development remaining for the future. The pursuit of development in education should deliberately contribute to this resolution.

Precision-Ambiguity

"There is a sharp contrast between the precision of specification and recordkeeping in high-technology projects and the managerial process associated with their effective pursuit. The latter is characterized by a highly fluid, iterative, and seemingly imprecise series of activities that require a high degree of personal interaction (p. 225)." The classical ideal of management that has for a decade been recognized as naive (Braybrooke and Lindblom, 1963) includes a set of milestones converging on the attainment of a precise solution to a problem that was specified with pristine clarity prior to beginning the effort. Never 'twas so, and never 'twill be in development in education or in any other field.

"In traditional management theory administrators are expected to collect and weigh facts and probabilities, make an optional decision, and see that it is carried out. In large-scale development projects, a clear sequence of action is not possible because of their extended duration, the many technical unknowns, the changing balance of power among interest groups, the continual discovery of new 'facts' and constantly changing constraints and pressures....It is assumed that the problems are simply and directly solved by rational analysis when, in fact, a great deal of interplay and negotiation may be necessary" (pp. 7-8).

A development effort that is conducted as a mechanical completion of milestones will either trivially advance the state-

of-the-art or intellectually misrepresent the complexity of its operations.

"Modern development programs have life histories filled with unanticipated crises, unpredicted barriers and impediments. What appear to be reasonable designs, given prior knowledge and experience, turn out to have neglected some small, crucial factor, and some subpart....fails to work. This, in turn, means that the subsystem may have to be redesigned to 'work around' the problem, which, in turn, affects other subsystems and the larger system....These complex technical endeavors....require not less but more human ingenuity, improvisation, and negotiation than old-style business and government organizations" (pp. 10 and 16).

Independence-Dependence

"A major paradox.. is that effectiveness in development programs requires a high order of responsible autonomy and the opportunity to innovate and even to change plans. But large scale projects... also require unbelievably precise integration and coordination among the parts. ..Thus a wide array of intellectual and economic commitments must be simultaneously focused on a very explicit task without destroying the motivations that release energy and commitment" (pp. 5 6).

The American society, historically and now, has placed a high value on independence. This tradition demands that both individuals and institutions be officially recognized as "independent." However, a mission orientation introduces constraints on all parties contributing to the mission.

"A mission orientation....clearly is not consistent with a literal interpretation of the 'independent contractor' concept. [All parties] must be able to act in concert to be immediately responsive to a program's needs. A certain degree of separation from external pressures that might prematurely abort potentially significant advances is also required. Thus, the development group needs a working arrangement that will insulate it from its environment, and a monopoly or near-monopoly of certain relationships is one way of achieving this goal. To get on with the job, the sponsoring agency is almost forced to make itself the central figure in a closely knit group of organizations, insulated from external pressures--from the environment--and therefore dependent upon the sponsor. To secure this relationship, the

sponsor is obliged to provide unusual guarantees as protection against risk, such as compensation for losses that may be incurred [with] approaches that show promise but eventually prove unfeasible Management of this style of relationship is of special significance because it is by no means limited to advanced technologies. In the future we can expect a much greater use of mission-oriented aggregations composed of a sponsoring agency and a diverse group of satellites who have banded together to achieve a major social or economic goal" (p 71)

Such interdependence includes profit making, as well as public organizations and individuals, as well as institutions Interdependence has never been strongly pursued in development in education since it has been viewed as a reflection of weakness rather than strength An opposite view appears to best forward both a mission orientation and a development enterprise A poignant anecdotal illustration of this point is NIE's curt referral of its contractors to the Small Business Administration for loan assistance in contrast to the elaborate agency efforts that led to arranging federal guarantee for the $250 million Lockheed loan

Matters of independency-dependency are often viewed as unilaterally involving individuals or institutions other than the sponsor but the effects are reciprocal A sponsor that disdains all interdependency relationships is itself totally dependent upon others, in forwarding its interests externally. This dependency typified NCERD and its predecessors in USOE

Competition-Cooperation

This dilemma is closely allied to that of independence-dependence Both competition and cooperation are each useful mechanisms for enchancing excellence. The accommodation of the incompatibilities of the two mechanisms appears to lie in a self-forcing, self-enforcing system "To achieve this goal, a pressure system must be devised that will function to correct significant errors and prevent major distortions from arising. Relying heavily on indirect means, management provides pressure in the right direction so that most of the time the system will be brought back to its original course. Management of large-scale endeavors essentially involves the skillful creation of such a pressure system" (p. 104).

The system envisioned is still an aspiration rather than a reality in any field of development. Techniques toward this end in educational development that have proved useful in practice are described in Schutz (1972).

Refinement-Completion

Research work, like woman's work is never done. Development work must be treated as complete at the earliest setting sun, although it is clear that it could be extended and refined to good effect for a much longer period. "Letting go" of a piece of work is one of the most difficult things for a novice in development to learn how to do gracefully. The tricks of the trade known to me are described elsewhere (Schutz 1970 a and b), but there is no "single best" resolution.

"The complex intermeshing of scientific needs, engineering requirements, budgetary limitations, organizational constraints, and personal goals and values almost ensures that project decisions will involve a complex of trade-offs among many different gains and a variety of losses. Experienced and knowledgeable participants cannot eliminate the need for trade-offs, but they can approach the bargaining with a realistic evaluation of the possible outcomes" (p. 64).

Effecting-Marginalizing

Even economists tend to prefer direct effects over marginal accomplishments when there is a choice between the two modes (Charlesworth, 1972). In development, marginalizing is often more efficient as well as more effective than direct manipulating.

Development efforts in education are simply too complex to be handled by one individual in a hands-on, do-it-yourself fashion. The development specialist "acts the role of a marginalist. He widens or narrows limits, adds or substracts weights where trade-offs are to be made, speeds up or slows down actions, increases the emphasis on some activities and decreases the emphasis on others" (p. 209). He finds that "there is often not a precise, rational solution to most questions, rather the answer is a product of flexible give-and-take" (p. 215). He "strives constantly

to keep an appropriate balance in relative effort for what are always somewhat conflicting objectives and to avoid the usual degredations by which high hopes are dashed on the rocks of 'realistic solutions'... The process thus becomes a kind of continuous test of the perspicacity, alertness, and omniscience of those involved in the project. As such, it provides very useful feedback to the manager, perhaps much more useful than the data provided by traditional appraisal mechanisms" (pp. 216-217)

Manpower Considerations

Considerations of manpower have been postponed to this point, not because human resources are incidental to development in education, nor because qualified persons are available in good supply. Neither could be much further from the case (Levien, 1971). However, unlike the conduct of research, the integrated group rather than the isolated individual is the reasonable unit for considering the conduct of development. This does not reduce the importance of the individual in any development enterprise. It simply requires greater attention to insuring an environment that will make it possible for each individual involved in the conduct of development to be professionally productive and personally satisfied.

It is thus inappropriate to impute the attributes of a researcher to create a "developer" role. Some persons have assigned the term "educational developer" to themselves or their students. However, a one-man "developer" will be superficially trained and will operate superficially. The conduct of development in education requires highly competent specialists, not prima donna generalists. Now, and likely forever, personnel qualified as journeymen contributors to development in education are likely to be trained and to identify themselves as discipline specialists rather than as "developers."

The temptation to anthropomorphize abstractions such as "development" and "evaluation" into "developer" and "evaluator" has been, however, compellingly popular. University training programs for "educational developers" have been established, and training materials for such programs have been solicited and

contracted for by USOE. These programs and materials can do little at present than to communicate irrelevant dogma and obsolete technology regarding development in education.

The technical sophistication of development in education is still so primitive, but is advancing so rapidly, that it appears both premature and inadvisable to attempt to pack it into degree programs. Books (e g Baker and Schutz, 1971, 1972) are feasible, and courses are, perhaps, reasonable, but any additional academic trappings are empty pretense.

The methodological and substantive competence of graduates of prevailing bachelors, masters, and doctoral level programs is quite adequate for development efforts The deficiencies in the training received by these individuals relevant to development in education are not in methodology or substance. The deficiencies pertain to personal and discipline attitudes inculcated by academic training that forward research contributions, but impede development contributions.

Fry (1972) has conveniently summarized the attitudinal dispositions that must be adjusted in moving from the university laboratory to the development laboratory.

1. *"The technical sophistication of a concept is no guarantee of its commerical success."* In the university laboratory, the cleverer the idea, the more attention it is likely to receive. In the development laboratory, the goal is the quickest, most direct, most simple, least expensive means of reliably accomplishing desired functions, technical sophistication is at best a means toward this end Conceptual complexity usually leads away from the goal.

2. *"The work of a development laboratory is creative and synthetic."* It is the creative synthesizer rather than the critical kibbitzer who forwards the work of a development laboratory. "Anyone with reasonable intelligence can do a good job of choosing between alternatives for objectives. The valuable man is the one who defines the need for a new activity, or who realizes that a certain characteristic of a product, which was brought to the present level only with apparently great difficulty, is in fact,

rather low in terms of what is ultimately possible."

3 *"Work in the development laboratory is frequently empirical manipulation of highly complex and poorly understood systems."* The plea, "We don't yet know enough," begs the development question, as do simplified model systems abstracted from the real or natural system of interest. In the development laboratory, personnel are perforce dealing with a whole process in its full complexity, whose mechanism is not fully understood and whose variables are incompletely defined. Moreover they are asked to affect changes in a relatively short time.

4 *"Work in the development laboratory is largely a group activity."* This point has been elaborated earlier. "In the development laboratory, the final product or process is rarely associated with one individual."

5 *"Development projects take much longer to complete than research projects."* Again the point has been made above. "Commercialization of an idea in the development laboratory may take up to ten years."

6 *"Because of the effects of process changes on efficiency, production functions may be reluctant to adopt such changes."* It is modest comfort to persons in education to recognize that production managers, like school administrators have concerns beyond technical soundness and financial benefits. "To the production operation in the short run, change, in the short run, means lower efficiency and higher unit costs. Manufacturing will never be as willing to adopt process changes as the [researcher] might anticipate."

For the forseeable future, the development-desirable predispositions enumerated above can best be produced in quick on-the-job orientation or in an internship in a good development laboratory in conjunction with an academic training program. Such internships would also be useful for established researchers. However for an established researcher to pass through the doors of a development laboratory is as difficult as for an established camel to pass through the eye of a needle. The reason has nothing to do with matters of heaven, but it has a lot to do with matters of earth.

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1. THE PROBLEM AND PROBLEM DELINEATION TECHNIQUES – William J. Gephart, Phi Delta Kappa. Presented at the Second National Symposium for Professors of Educational Research, sponsored by Phi Delta Kappa, Boulder, Colorado, November 21, 1968. A discussion of the nature of the concept "problem" as related to educational research with a discussion of several techniques useful in problem identification and delineation. $1.00
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